Assessment of Additional Measures to Maximize the 8-Lane At-Grade Alternative's Ability to Meet Purpose and Need

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Purpose of the Analysis

The purpose of this analysis is to identify and discuss various modifications to the 8-lane at-grade (8LAG) alternative WisDOT previously developed, in an effort to vet the alternative's configuration. The alternative was developed during the initial alternatives development phase in late 2012, and has been modified and refined throughout the course of 2013.

Additional study of the 8LAG alternative continues because of the stark differences in construction cost, some impacts, and other purpose and need factors between it and a double-deck freeway (DD) configuration.

Design-year traffic operations on I-94 under the 8LAG alternative would meet level of service D in most locations, but would drop to level of service E along a short segment adjacent to the cemeteries. The 8LAG alternative would significantly improve safety on this segment of I-94 compared to the No-Build Alternative, thereby enhancing I-94's ability to serve as a key transportation route by reducing both congestion and crashes. Further, the 8LAG alternative would replace the existing deteriorating pavement. Overall, the 8LAG alternative would meet some aspects of the project's purpose and need objectives, though in most aspects at a level below what the DD alternative can provide. However, the 8LAG alternative has fewer environmental impacts, and is significantly less costly than is the DD alternative.

8-Lane At-Grade Alternative Development To Date

Several alternatives were evaluated for the I-94 East-West Corridor study. The alternatives were based on the regional transportation planning process carried out by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and recommendations made in SEWRPC's adopted *Regional Transportation System Plan for Southeastern Wisconsin: 2035* (SEWRPC 2006; updated and reaffirmed in June 2010). The regional transportation plan is designed to serve the land use plan and the forecast future travel demand derived from the population and employment growth and development pattern envisioned in the land use plan. The system planning and recommendation process began by considering and developing links and strategies, including non-capacity-expansion elements such as public transit, and bicycle and pedestrian facilities. Transportation systems management (TSM) and travel demand management (TDM) elements also were investigated and included in plan recommendations. Only following the implementation of these elements was capacity expansion on the arterial street and highway/freeway system considered to address traffic volume and congestion.

As noted, the 8LAG alternative initially was developed along with several other build and non-build alternatives in the second half of 2012. The initial alternatives development coincided with review of the purpose and need statement by participating and cooperating agencies and with public outreach on purpose and need. The purpose of the project, which drew no substantive comments from participating and cooperating agencies, is documented in detail in Section 1 of the preliminary Draft EIS, and summarized as follows:

- Maintain a key link in the local, state, and national transportation network.

- Address the obsolete design of I-94 to improve safety, which includes potentially replacing left-hand entrances and exits, improving sight distances, widening narrow shoulders, eliminating other roadside hazards, and providing proper weaving distances between exit and entrance ramps.
- Replace deteriorating pavement.
- Accommodate future traffic volumes at an acceptable LOS.

The need for the project is demonstrated by several factors, most notably:

- High existing crash rates
- Substandard existing freeway geometric deficiencies (typical section, horizontal and vertical alignment, ramp spacing and location, and others)
- Poor operations and increasing delay under both existing and projected future traffic volumes

Because of the Soldiers Home NHL and two private cemeteries adjacent to it, I-94 through the cemeteries consists of six 12-foot lanes, 1.5-foot inside shoulders in both directions, a 4-foot eastbound outside shoulder, and a 10-foot westbound outside shoulder. There is a barrier/wall outside the eastbound lane and a fence along the outside westbound lane. See Exhibits 1 and 2 for the existing typical section and for plan view dimensions and location. WisDOT and FHWA committed early on in the study that graves will not be disinterred from any of the cemeteries as a result of this project.

The AASHTO and WisDOT standard lane width is 12 feet and the standard shoulder width is 12 feet.

At its narrowest point, roughly 110 feet is available for the construction, clearance and footprint of I-94 between the cemeteries. Using this width of 110 feet, the study team developed 10 options for allocating space for lanes, shoulders, and barriers (Table 1). After reviewing them, the study team identified reasons for each being eliminated or retained. A 6-foot width for roadway curvature,[1] constructability, and the westbound outside barrier is included in all the options listed below. This leaves 104 feet for an at grade typical cross section. One of the ten options is the 8-lane at grade typical section with 8 11-foot lanes and 2-foot inside and outside shoulders (Option 3), which has been shown at public meetings and agency meetings through much of 2013 as the best option to maximize safety and traffic operations in the width available. It remains the one 8LAG alternative still under consideration.

The traffic operations were assessed on a 6-lane modernization alternative and an 8-lane modernization alternative to determine if they would operate at an acceptable LOS (D or better) in the design year peak hour assuming that all the regional plan's recommended transit projects were included. The results of the 6-lane alternative analysis indicated that several segments of I-94 would operate at LOS E and F, not working at an acceptable level of service.

[1] The freeway is curved through the cemetery segment. This takes up some of the available width because the roadway curve does not fit concentrically into the available space.

TABLE 1
Cemetery Area Cross Section Dimensions

Options		Reason Dropped
Option 1		
Eight 12-foot lanes	96 feet	
Median (two 3-foot shoulders and 2-foot single barrier)	8 feet	shoulders 25% of standard
Eastbound outside shoulder	1 foot	8% of standard.
Remaining width for westbound outside shoulder	-1.13 feet	does not fit footprint
Option 2		
Eight 12-foot lanes	96 feet	
Median (two 1-foot shoulders and 1-2-foot single barrier)	4 feet	shoulder 8% of standard
Eastbound outside shoulder	2 feet	shoulder 16% of standard
Remaining width for westbound outside shoulder	1.87 feet	shoulder 15% of standard
Option 3 (remains)		
Eight 11-foot lanes	88 feet	
Median (two 2-foot shoulders and two 2-foot barriers 2 feet apart)	10 feet	shoulder 16% of standard
Eastbound outside shoulder	2 feet	shoulder 16% of standard
Remaining width for westbound outside shoulder	3.87 feet	shoulders 32% of standard
Option 4		
Eight 11.5-foot lanes	92 feet	
Median (two 4-foot shoulders and 2-foot single barrier)	10 feet	shoulder 33% of standard
Eastbound outside shoulder	1 foot	shoulder 8% of standard
Remaining width for westbound outside shoulder	0.87 foot	shoulder 7% of standard
Option 5		
Eight 11.5-foot lanes	92 feet	
Median (two 3-foot shoulders and 2-foot single barrier)	8 feet	shoulder 25% of standard
Eastbound outside shoulder	2 feet	shoulders 16% of standard
Remaining width for westbound outside shoulder	1.87 feet	shoulder 15% of standard
Option 6		
Six 12-foot lanes	72 feet	6 lanes does not work operationally
Median (two 3-foot shoulders and 2-foot single barrier)	8 feet	shoulders 25% of standard
Eastbound outside shoulder	12 feet	
Remaining width for westbound outside shoulder	11.87 feet	

Option 7		
Six 12-foot lanes	72 feet	6 lanes does not work operationally
Median (two 8-foot shoulders and 2-foot single barrier)	18 feet	shoulders 67% of standard
Eastbound outside shoulder	8 feet	shoulders 67% of standard
Remaining width for westbound outside shoulder	5.87 feet	shoulder <50% of standard
Option 8		
Six 12-foot lanes	72 feet	6 lanes does not work operationally
Median (two 4-foot shoulders and two 2-foot barriers 2-foot apart)	14 feet	shoulders 33% of standard
Eastbound outside shoulder	10 feet	shoulders 83% of standard
Remaining width for westbound outside shoulder	7.87 feet	shoulder 65% of standard
Option 9		
Six 12-foot lanes	72 feet	6 lanes does not work operationally
Median (two 4-foot shoulders and 2-foot single barrier)	10 feet	shoulders 33% of standard
Eastbound outside shoulder	12 feet	
Remaining width for westbound outside shoulder	9.87 feet	shoulder 82% of standard
Option 10		
Six 12-foot lanes	72 feet	6 lanes does not work operationally
Median (two 6-foot shoulders and 2-foot single barrier)	14 feet	shoulders 50% of standard
Eastbound outside shoulder	10 feet	shoulders 83% of standard
Remaining width for westbound outside shoulder	7.87 feet	shoulders 65% of standard
Option 11		
6 permanent lanes	66 feet	
Median (two 12-foot shoulder/peak hour lane with 2-foot single barrier)	26 feet	Shoulder 16% of standard during peak hour
Eastbound outside shoulder	6 feet (4+2)	Shoulder 50% of standard
Westbound outside shoulder	6 feet (4+2)	Shoulder 50% of standard

Comparison of 8-Lane At-Grade to Purpose and Need

Safety

The desirable design criteria values presented in WisDOT's *Facilities Development Manual* fall in the middle to upper range of the AASHTO design criteria values. AASHTO guidance strongly recommends that middle to upper range values be used in most cases, and that the minimum design criteria values be used only under special circumstances. The following are some of the benefits of wider lanes, shoulders and clear zones:[2]

- Increased safety and comfort for the driver
- Decreased collision rates with increased lane, shoulder and clear zone widths as shown in studies
- Increased capacity of the highway
- Increased mobility on higher speed highways (freeways, expressways, higher order arterials) by increasing driver comfort when traveling at higher speeds

[2] Source: WisDOT, *Facilities Development Manual,* Procedure 11-15-1

- Increased room for driver to recover control of their vehicle and return to the roadway or at least achieve significant decelerations before striking a fixed object
- Increased room for the lateral placement of vehicles as speed, volume and percentage of heavy, wider vehicles increases
- Increased room to accommodate vehicle "off-tracking" along horizontal curves
- Increased room for bicycle and pedestrian accommodations
- Improvements for drainage, disabled vehicles, collision avoidance maneuvers, and structural support of the traveled way
- Shoulders provide space for enforcement activities (a minimum of 8 feet is required)
- Shoulders provide space for maintenance activities (including snow removal)

Safe and efficient traffic operations can be adversely affected by not providing adequate shoulder width. According to AASHTO and FHWA, 12 feet is preferred for both the lane width and shoulder width for the reasons noted above.[3]

According to the *Safety Prediction Methodology and Analysis Tool For Freeways and Interchanges* (prepared for National Cooperative Highway Research Program [NCHRP], Project No. 17-45) going from a 12-foot lane to a 10.5-foot lane would result in a 7.5 percent increase in the number of fatal + injury crashes. In addition, going from a 6-foot inside shoulder to a 2-foot inside shoulder would result in an 8 percent increase in the number of fatal + injury crashes. The ISATe analysis completed for the 8LAG Alternative supports this research. The crash frequency of Option 3 from Table 1 (11-foot lanes, 2-foot shoulders) was compared to the crash frequency of a full width typical section (12-foot lanes, 12-foot shoulders). Results indicate that Option 3 would have a 60 percent higher crash frequency due to the narrow lanes combined with the narrow shoulder. Nonetheless the project team believes that the 11-foot lanes and 2-foot shoulders is the best combination of lane and shoulder width in the cemetery segment. This is because narrowing the shoulder less than 2 feet to provide 12-foot lanes would increase the likelihood of striking the barrier wall with even a modest deviation from the lane. Conversely, narrowing lane width to less than 11 feet to increase shoulder width would be less safe than providing for 12-foot lanes.

Chapter 12 of AASHTO's *Highway Safety Manual* states that reducing clear distance from 5 feet to 2 can be expected to increase contact with that fixed object (i.e. the concrete barrier) by 100 percent (Table 12-20).

Reducing the outside shoulder width to a narrower width would eliminate safe storage for disabled vehicles and law enforcement/emergency services. AASHTO's *Highway Safety Manual* research on outside shoulder width on rural roads Chapter 12, Table 11-17 indicates that narrowing the right shoulder would have the following consequences:

- Narrowing from 8 feet to 4 would increase crashes by 9 percent.
- Narrowing from 8 feet to 2 would increase crashes by 13 percent.
- Eliminating the right shoulder would increase crashes by 18 percent.

WisDOT's ISATe analysis of the 8LAG alternative predicted that I-94 would expect to experience 30 percent more total crashes than would occur if a double deck alternative were constructed.

Capacity

The 8LAG would operate at LOS E in the design year peak hour. FHWA guidance calls for freeways to provide LOS C; however, in the *I-94 East-West Stadium Interchange Study* technical memorandum (August 31, 2012) from the consultant team to WisDOT, the team recommended (and FHWA agreed to) LOS D as a goal for the traffic operations on the project. In urban areas like Milwaukee County, the impacts resulting from achieving

[3] *AASHTO's A Policy on Geometric Design of Highways and Streets (GDHS), Chapter 4 Cross Section Elements.*

LOS C would be extensive and costly. In a further reflection of the tight urban corridor with significant occurrences of major event traffic (e.g., baseball games) in which the project is located, WisDOT and FWHA agreed to analyze LOS calculations on the 200th highest hour of traffic in a year, rather than the typical design standard 30th highest hour of traffic in a year. LOS E is described in the AASHTO's GDHS as "unstable flow, operating at capacity. Flow becomes irregular and speed varies rapidly because there are virtually no usable gaps to maneuver in the traffic stream and speeds rarely reach the posted limit. Vehicle spacing is about 6 car lengths, but speeds are still at or above 50 mph. Any disruption to traffic flow, such as merging ramp traffic or lane changes, will create a shock wave affecting traffic upstream. Any incident will create serious delays. Drivers' level of comfort becomes poor."

Traffic Operations

WisDOT assessed the traffic operations of the No-Build Alternative, a 6-lane modernization alternative, an 8-lane at-grade alternative, and an 8-lane double deck alternative. No 6-lane double deck alternative was evaluated because 6 lanes could be accommodated at grade through the cemetery segment with 12-foot lanes in each direction and one 10-foot shoulder in the westbound direction, as is in-place today.

The 6-lane at-grade alternative will operate at a LOS E and F at several locations.

The 8LAG will operate at a LOS E in the design year through the cemetery section only if all SEWRPC-identified TDM and TSM measures are implemented, if a doubling of transit service is realized, and only if the Hawley Road interchange is closed. In other words, traffic performance will be far worse for the 8LAG alternative is any or multiple of these other conditions are not met by the design year. As discussed elsewhere, there is inadequate space available to accommodate ramp tapers and gore areas for an eastbound on-ramp and/or a westbound off-ramp in this constrained location. See "Additional Elements Considered Beyond Those in the Regional Plan" section elsewhere in this memorandum for a discussion of partial interchange access at Hawley Road for the 8LAG alternative.

If the assumptions above are realized, it may be possible to obtain more a consistent level of service (i.e. LOS D where the average vehicle density is 25% less than the LOS E threshold) through the cemetery section if 4,400 vehicles per day, including 350 cars in the PM peak hour, were diverted off of the freeway and onto the adjacent roadway network. To obtain a mid-range LOS D with the 8LAG, 10,100 vehicles per day must be diverted for the combined eastbound and westbound directions, or about 800 vehicles in the peak hour (Table 2).

It should be noted that even though an acceptable level of service can possibly be achieved on the freeway mainline by diverting no less than 4,400 vehicles per day, the freeway corridor as a whole will be substantially less reliable in terms of overall operations and predictable travel times due to the increased effect that random influences (weather, incidents, etc.) will have on the 8LAG.

Most, if not all, of the diverted traffic would likely reroute to I-894, Greenfield Avenue, Blue Mound Road, Wisconsin Avenue, National Avenue and other parallel east-west arterials. This would increase congestion and have significant impacts to adjacent residents and businesses along these routes.

Under the 8LAG, it is possible that enough additional capacity could be provided on these arterials by eliminating on street parking, and/or implementing signal timing improvements, including FTMS and "smart-signal" technologies.

Table 2
Daily Vehicle Volume Diversion

		I-94 Eastbound			I-94 Westbound			Total	
		PM Peak Volume (veh/hr)		Estimated Daily	PM Peak Volume (veh/hr)		Estimated Daily		
Scenario	LOS	Total	Estimated Diversion	Diversion (veh)	Total	Estimated Diversion	Diversion (veh)	PM Peak (veh/hr)	Daily (veh)
8 LAG	"high" D	7,450	350	4,400	7,250	0	0	350	4,400
8 LAG	"mid" D	7,100	700	8,800	7,150	100	1,300	800	10,100
6 LN Mod	"low" D	5,000	2,800	35,000	5,050	2,200	27,500	5,000	62,500

If a 6-lane modernization concept is pursued, however, diverting 62,500 vehicles per day would likely require through capacity expansion on the arterial roads, resulting in significant right-of-way acquisition and the resultant strip-taking and residential and/or business relocation impacts associated with such acquisition.

Most of the focus for the 8LAG design has been on operations through the cemetery segment itself, especially eastbound during the 2040 PM peak hour, but it should be noted that operations in this area are directly related to, and driven by, the previous design of the downstream eastbound system exit ramp to USH 41/341. The exit ramp under the 8LAG alternative was designed as a tapered, single-lane exit, which would be over capacity during the design year PM peak hour and have upstream mainline impacts through the eastbound cemetery segment. As a result, the forecasted mainline LOS E in the eastbound PM peak hour was compounded by the exiting traffic at the USH 41/341 eastbound exit ramp. Based on traffic analysis of the exit ramp, the tapered design would require approximately 8,300 vehicles per day to divert from the exit ramp in order to operate at an acceptable level of service (Table 3).

TABLE 3
Daily Vehicle Volume Diversion on System Ramp

		PM Peak Volume (veh/hr)		Estimated Daily
Scenario	LOS	Total	Estimated Diversion	Diversion (veh)
8 LAG	D	1,050	1,000	8,300

However, as the 8LAG design has continued to be refined, the geometry of this system ramp, of the system on-ramp westbound, and its relation to the 68th-70th off-ramp, and other access elements have been modified in a manner to best “balance” the dimensions of various weaving lengths and right-of-way needs. As such, the eastbound system exit ramp to USH 41/341 has been redesigned in the 8LAG alternative as a 2-lane parallel exit, which provides additional capacity to accommodate the system ramp demand while avoiding impacts to the NHL’s northeastern corner.

It should be noted that the design change to the eastbound system ramp exit does not fix the mainline capacity constraint and resulting LOS E on I-94 that is inherent to the 8LAG alternative, but does help to eliminate the upstream operational impacts of the USH 41/341 exit ramp. In addition, it is an example of the project team’s continued efforts to “optimize” the 8LAG design to the greatest extent possible.

Elements assumed to be implemented with All Build Alternatives, Including the 8LAG Option

This section documents what elements and assumptions are included in SEWRPC’s Regional Transportation Plan. It is important to reemphasize that SEWRPC considers capacity expansion as a last resort, only if there is congestion that cannot be addressed by transit, TSM, TDM, and other noncapacity expansion strategies and elements. While most of the TSM measures have already been implemented, the transit and TDM measures have not, and will be difficult to implement by the design year based on current trends of transit service and funding availability and allocations.

The following elements are included in the Regional Transportation System Plan, in conjunction with 8 lanes on I-94 between 70th and 16th streets.

Public Transit Element

- Development of true rapid bus transit (doubling from levels in place in 2005)
- Development of express transit systems
- Expansion of transit service (increasing weekday vehicle-miles of service by 59 percent)

Actual transit service has dropped 20 percent since the 2006 plan was adopted, further widening the gap between current transit usage and the levels envisioned in the plan to address demand. This suggests that the doubling of 2005 transit levels may not occur, which would result in more traffic on I-94 than forecast.

Based on current transit usage in the I-94 corridor between the Zoo and Marquette interchanges, peak hour transit use would have to triple in order to divert enough vehicles off I-94 for the 8LAG to reach LOS D in the design year peak hour. Note that this is not merely tripling transit *service* but tripling transit *use*. It would be difficult to triple transit use among I-94 commuters when there is no travel time savings compared to using a car; there is no incentive for people to switch to transit. In the absence of some of the more dramatic TDM recommendations below like increased parking rates and/or reserved bus lanes on arterials that either increase costs for single-occupancy commuters or dramatically decrease travel times for transit users, a threefold increase in transit usage will remain elusive. Furthermore, transit service on I-94 is designed for downtown workers that commute from western Milwaukee or Waukesha counties. WisDOT's 2012 aerial origin-destination survey (SkyComp) determined that only 40 percent of vehicles on I-94 travelled all the way through the corridor (entered I-94 west of 84th Street and exited east of 25th Street, and vice versa). Even if one assumes that all of these vehicles represent downtown workers rather than other through traffic, the increased transit usage would need to come entirely from the subset of I-94 users that are downtown commuters.

For additional discussion of the transit element see Section 2.4.2 of the DEIS.

Bicycle and Pedestrian

- Paved and widened shoulders, widened outside travel lanes, bicycle lanes, or separate bicycle paths should be considered as each segment of the parallel urban arterial street system is resurfaced, reconstructed, or constructed
- Expanding off-street bicycle paths from 238 miles to a 575-mile system

In constrained urban environments like the City of Milwaukee, it is difficult to widen outside travel lanes or provide bicycle lanes. Furthermore, the number of bicycle and pedestrian trips is a very small percentage of trips in the region. The robust expansion of bike and pedestrian opportunities will not divert a noticeable amount of trips from I-94.

Transportation Systems Management

The majority of Transportation Systems Management measures have been implemented.

Freeway Traffic Management.

- Operational Control
  - Maintaining existing freeway system traffic detectors and installing additional detectors at 0.5-mile intervals
  - Installing ramp meters and expanding the ramp meter control strategy of varying vehicle release rates
- Advisory Information
  - Maintaining existing variable message signs and providing additional variable message signs on the freeway and surface arterials leading to the most heavily used on-ramps
  - Maintaining the regional traveler information system (511)

- Proposed Incident Management
  - Maintaining and expanding the network of closed circuit TV cameras which allow for the rapid detection of and appropriate response to an incident
  - Expanding the provision of enhanced reference markers to be placed at 0.1-mile intervals
  - Expanding freeway service patrols to aid in the rapid removal of disabled vehicles and assist in incident clearance

Surface Arterial Street and Highway Traffic Management.

- Improving and expanding coordinated traffic signal systems
- Implementing intersection improvements (adding right-and/or left-turn lanes or upgrading the type of traffic control at the intersection)
- Implementing curb-lane parking restrictions during peak traffic periods as needed
- Applying access management standards for the location, spacing and operation of driveways, median openings and street connections
- Expanding the advisory information network to include surface arterial street and highway travel

Parking Management and Guidance.

- Operational improvement projects for implementation based upon the transportation systems management recommendations

Travel Demand Management

Travel Demand Management (TDM) measures could have some impact on freeway volumes, individually or together they could possibly help raise LOS on this segment of I-94 to LOS D. But to be effective they must be implemented on a regional basis. TDM measures such as HOV lanes must be executed system wide, otherwise congestion will still be an issue adjacent to the project, and the efficiency to move transit vehicles, vanpools and carpools will not be realized.

TDM measures included in the regional transportation plan are:

- Preferential treatment for high-occupancy vehicles (reserved bus lanes along arterial streets and highways, transit priority signal systems, voluntary employer-provided preferential parking for those who carpool)
- Park-and-ride lots
- Transit pricing programs (annual transit pass program enhanced and expanded to employers)
- Personal vehicle pricing (employers begin charging for parking and increase user fees-motor fuel tax and vehicle registration fees)
- Aggressive promotion of transit use, bicycle use, ridesharing, pedestrian travel, telecommuting, and work-time rescheduling
- Transit information and marketing (websites with travel time information etc.)
- Detailed site-specific neighborhood and major activity center land use plans

Some of these measures have been implemented to varying degrees.

Arterial and Highway Expansion

- I-94, I-894, and I-94/43 (between the Mitchell and Marquette interchanges) expanded from 6 to 8 lanes
- Additional capacity on select arterials (217 route miles in the 7-county region)

Additional Operational Elements Considered Beyond Those in the Regional Plan

The following additional elements have been considered with the 8LAG but are not included in the Regional Plan.

Truck Restrictions During Peak Hours

The AM truck percentage for the I-94 corridor is roughly 6.4 percent and the PM truck percentage roughly 4.0 percent. Restricting truck traffic from this segment might improve LOS to D, by diverting roughly 320 trucks during the peak hour. This would cause issues on other parts of the freeway system and local arterials. It would have an adverse effect on businesses in the City of Milwaukee that would not be experienced by businesses outside the City.

Buses on Shoulders

This would require going to 3 lanes throughout the corridor because under the 8LAG there is no shoulder for buses to use. See Section 2 of the DEIS. There is not a continuous 12-foot shoulder on I-94 under any of the alternatives. Nor is there a 12-foot inside shoulder in the eastbound approach to the Marquette Interchange. This would need to be implemented corridor-wide in order to have it operate successfully. Providing the 12' shoulders throughout the I-94 corridor would be very costly and have significant human and natural environmental impacts.

Automatic On-Ramp Closures during peak hours

Closing the 68th Street eastbound on-ramp, the embedded interchange on-ramps, and/or the US 41 W-N/ W-S System ramp 6 to 8 hours each day may decrease traffic volumes on the west leg of the project and likely improve LOS on I-94. However, freeway volumes within the limits of the study area would likely remain the same, as the access closures would divert additional traffic (beyond what is potentially diverted due to the narrow cross-section; see previous section 8-Lane At-Grade Alternative Development to Date) to adjacent on-ramps via local arterials such as Greenfield Avenue, National Avenue, Bluemound Road, and Wisconsin Avenue. The regional travel demand model volumes on these arterials suggest that the model assumes future capacity expansion on portions of Greenfield and National Avenues through parking restrictions or other methods, but not the peak period closures in access to the freeway. In addition, closing some freeway ramps during peak hours would not meet driver expectations. The W-S ramp is also a main artery to Miller Park. Considering that most games begin at 7PM, closing off the ramp during peak hours means closing it when fans are arriving for a game. The closure of on-ramps is also contrary to the strong public and local government feedback to not eliminate any access to the freeway.

According to FHWA's *Ramp Management and Control Handbook* (January 2006), *Chapter 5.2.2,* 'Ramp closures change traffic patterns that have been established over a substantial period of time and therefore should be rarely considered for situations where another ramp management strategy may be successfully deployed.' Closures will have significant impact on the existing traffic patterns, and will result in traffic diverting to upstream and downstream ramps. The traffic problems that would occur at the closed ramp would be pushed to adjacent ramps through the corridor and potentially create new, unintended operational issues.

In addition, diverted traffic would move to the already stressed parallel local roads. Potential negative impacts of ramp closures include:

- Potential for traffic diversion.
- Promotion of longer trips.
- Increases in fuel consumption and emissions (for diverted trips).

    - Diverted vehicles are forced to take longer trips via the local street network to access adjacent service interchanges and as a result they incur longer travel times and an increase in fuel consumption and emissions
- Socio-economic changes (e.g., neighborhood and business impacts).
    - Additional traffic on the local street network due to ramp closures would likely necessitate strip taking of on-street parking to accommodate the additional demand, which effects businesses
    - Additional noise on local roadways due to the increase in traffic volumes
- Changes in local land values.
    - Loss of on-street or near-by parking for businesses
    - Potential loss of mobility and direct freeway access

Restrictive On-Ramp Metering Using Adaptive Dynamic Ramp Metering during Peak Hours A strategy related to the automatic on-ramp closure during peak hour strategy is the potential implementation of restrictive ramp metering during the peak hours using adaptive dynamic ramp metering systems to both manage the traffic demand entering I-94 and to discourage any local trips that both enter and exit I-94 within the project corridor limits. Similar to the automatic on-ramp closures, this may marginally decrease the traffic volumes on I-94, diverting those local trips to the local arterials, and potentially improving the LOS on I-94. Dynamic ramp metering uses active inputs in the form of volume, occupancy and queue length to an algorithm that changes ramp meter timing to aid in managing recurring congestion on I-94 created by high volumes of entering vehicles. This system would include installing sensors along the mainline and ramps and queue detectors on the adjacent local signalized intersections that would communicate back to the State Traffic Operations Center (STOC). Another key factor of this strategy is to provide sufficient length at the on-ramps to store the queues of entering vehicles without negatively impacting local arterial operations.

Lane Control System

Overhead lane-specific signals would denote a red "X" if travel in the lane is prohibited and a green arrow if travel is permitted or closing off a lane when an incident occurs). This would not increase capacity of I-94. It is designed to mitigate the adverse effect of incidents by informing drivers of upcoming lane closures. Closing a lane during off-peak hours would allow a shoulder to be provided on one side of the freeway but there would be no shoulder during peak hours, when it is most needed to avoid disruption to traffic from incidents.

Another option to installing the overhead lane-specific signals is to provide similar functionality through the installation of more frequent full-color; full-matrix dynamic message signs (DMS) either overhead or along I-94 that can warn drivers of changing traffic conditions, incidents or maintenance operations with a variety of written or graphical messages.

Queue Warning Systems

Advanced full-color; full-matrix DMS either overhead or along I-94 warning the driver of slower speeds and congested conditions ahead to reduce the probability of secondary and rear-end crashes by giving drivers more time to react to changing road conditions, with emphasizing additional signing in areas of limited sight distance. Queue sensors supporting the queue warning systems must be installed throughout the corridor with close spacing that would communicate to the STOC and recommends messages to be posted on the DMS to warn of the changing traffic conditions ahead. This would likely decrease capacity and operations on I-94 by reducing throughput but could reduce the likelihood of crashes.

Variable Speed Limits

Advanced overhead signs warning the driver of slower speeds and reducing speed during stop and go traffic to reduce the probability of a crash by giving drivers more time to react to changing road conditions. This would likely decrease capacity and operations on I-94 by reducing throughput but could reduce the likelihood of crashes. In 2009, Missouri Department of Transportation completed a study of variable speed

limits on the Missouri side of the I-270/I-255 loop around St. Louis a year after the variable speed limit signs were in place. Noticeable benefits were observed with respect to reduction in the number of crashes, but limited benefits were provided in terms of improvements to overall mobility and capacity along the corridor.

Managed Lanes

A challenge to implementing managed lanes, either buffer or barrier-separated, on this segment of I-94 is that over 60 percent of vehicles that travel I-94 between 70th and 16th streets are entering or exiting I-94 at one of the interchanges in the corridor. Managed lanes are usually, but not always, constructed along the median or inside lane of the freeway, typically to serve mid- to long-range commuter trips and through trips, rather than local trips. So, drivers that want to exit the freeway at one of the many service interchanges on I-94 in the study area would have to cross over two to three lanes of traffic to reach an exit ramp. Drivers entering the freeway that want to use the managed lanes would also have to weave across two to three lanes of traffic. This reduces the LOS on the freeway (NCHRP 2012). Weaving at the downstream end of the managed lanes also needs to be considered. As the managed lane ends and managed lane traffic begins to merge with traffic in the general purpose lanes, weaving would take place with traffic from the managed lane potentially moving at different speeds than the general purpose lanes. Like several other measures noted above, this would need to be implemented regionally to be effective. See Section 2.4.5.3 of the Draft EIS.

Half-Hawley Interchange

There is inadequate space available to accommodate ramp tapers and gore areas for an eastbound on-ramp and/or a westbound off-ramp at the Hawley Road Interchange due to the constrained location adjacent to the cemeteries, and WisDOT's and FHWA's determination to not impact graves in any of the adjacent cemeteries. An eastbound off-ramp and westbound on-ramp can be constructed, but would feature short and substandard weaves between the eastbound 68th Street on-ramp and eastbound Hawley Road off-ramp, and the westbound Hawley Road on-ramp and westbound 68th off-ramp. Additional engineering and traffic work is underway to investigate the viability of a half-diamond interchange in this location. Traffic LOS will be determined based on diversion forecasting of modified access to and from I-94 at Hawley Road, and geometrics will be developed for both an auxiliary lane configuration, and for a collector-distributor road configuration to address the weaving issues discussed above.

Safety Elements Considered

The following additional safety elements have been considered with the 8LAG.

Dynamic Message Signs (DMS)

DMS are electronic sign boards connected to the STOC used to display information on the highways. Operators are able to place messages on the DMS to alert drivers of incidents ahead, maintenance, snow removal operations, ramp or lane restrictions and other important information about current or future highway conditions. DMS would also be used to provide driver information such as travel times, construction zones and Amber alerts. The advanced warning provided by the DMS would encourage merging and lane changing ahead of a potentially restricted segment. DMS are operating in the state of Wisconsin, and will be evaluated with the 8LAG.

Ramp Gates at On-Ramps

Temporary ramp closures with a ramp gate is a strategy generally considered for safety benefits during construction, to perform maintenance activities, managing special events, when severe weather conditions are present or when travel on a roadway is unsafe, and if an incident has occurred on the freeway. Ramp gates are already operating in southeast Wisconsin, and will be evaluated with the 8LAG.

Solid Pavement Marking

The cemetery section contains an approximate 2800' radius in addition to the 11-foot lanes and 2-foot shoulders. Because of this, lane changing is not recommended within the segment. The use of a single 8-inch

solid white stripe between Mitchell Boulevard and Hawley Road would discourage weave maneuvers, likely decreasing the frequency of incidents.

Linear Delineation and Reflective Panels

Linear delineation and reflective panels can be placed along the barrier on the outside of the curve through the cemetery section. According to FHWA's *Safety Evaluation of Improved Curve Delineation* Techbrief dated August 2009, improved delineation will allow for drives to have better visibility when approaching curves by increasing visual cues, provide positive guidance, encourage drivers to decrease their speed into the curve and can be helpful during nighttime conditions.

Advanced Warning Signs

Signs can be used to warn drivers in advance of narrow lanes and shoulders. Advanced warning signs used in conjunction with some of the additional safety measures can improve the safety of the 8LAG alternative.

Conclusion

The 2006 regional transportation plan has aggressive transit assumptions, recommending a doubling of transit. However, actual transit service has declined 20 percent since the plan was adopted. Local, county, state, or special districts implement recommendations for the transportation facilities and systems they have jurisdiction over as they see fit and funding allows. History shows little success in implementing transit and other TDM/TSM measures listed above. The I-94 East/West study has incorporated such measures and assumptions into the design year traffic analysis, but if these elements are not implemented, additional volume and the resulting congestion can be expected on the freeway, not only by the design year but well in advance of that period. Many of these measures need to be implemented regionwide, yet there is no regionwide consensus, or mechanism in place, to execute them. Diverting traffic to parallel east-west arterials such as Greenfield and National Avenues has been included in this analysis. These strategies, including removing parking and introducing additional arterial traffic into neighborhoods and past business districts, are controversial in nature. Beyond the traffic and congestion implications, it can be expected that arterial crashes and crash rates would rise on these arterials.

The I-94 East West Stadium Interchange study falls within both a heavy daily urban commuter route and a highly used special event corridor. Because of these two factors, a LOS 'D' for the 200th-highest hourly volume, is the goal for traffic operations, rather than a LOS 'C'. By using a lower LOS, there is more of a risk for an incident to occur on the freeway. Building eight 11-foot lanes with 2-foot inside and outside shoulders will not provide any refuge for disabled vehicles, for law enforcement activities, or for maintenance activities including snow removal. The 8LAG alternative will operate at or near capacity in the design year on the west leg/cemetery section, creating traffic bottlenecks. Without a more acceptable typical section, including adequate through-lane capacity and standard-width traffic lanes and shoulders, any traffic incident will result in compounded operational delays and increased crash potential.

Deployment of all of the SEWRPC-recommended elements is needed with the 8LAG to achieve minimal LOS D in the design year. Additional measures may help alleviate some congestion, but do not address the substandard geometrics and typical section limitations, and are not included with the 8LAG alternative. As stated in the American Highway Users Alliance study of Unclogging America's Arteries (as referenced on FHWA's website), "A sound base infrastructure must already exist before transportation operations can be used. Only so much extra efficiency can be squeezed out of an already-stressed highway system."

Shortly after being sworn in last year, US DOT Secretary Anthony Foxx said "As I begin my tenure at DOT, I plan to focus on three key areas, the first of which should come as no surprise to anyone who knows this Department: *safety*. As it has been for Secretary LaHood, the dedicated DOT workforce, and DOT's many

partners and stakeholders, ensuring that America's transportation system is the safest in the world will be my top priority."[4]

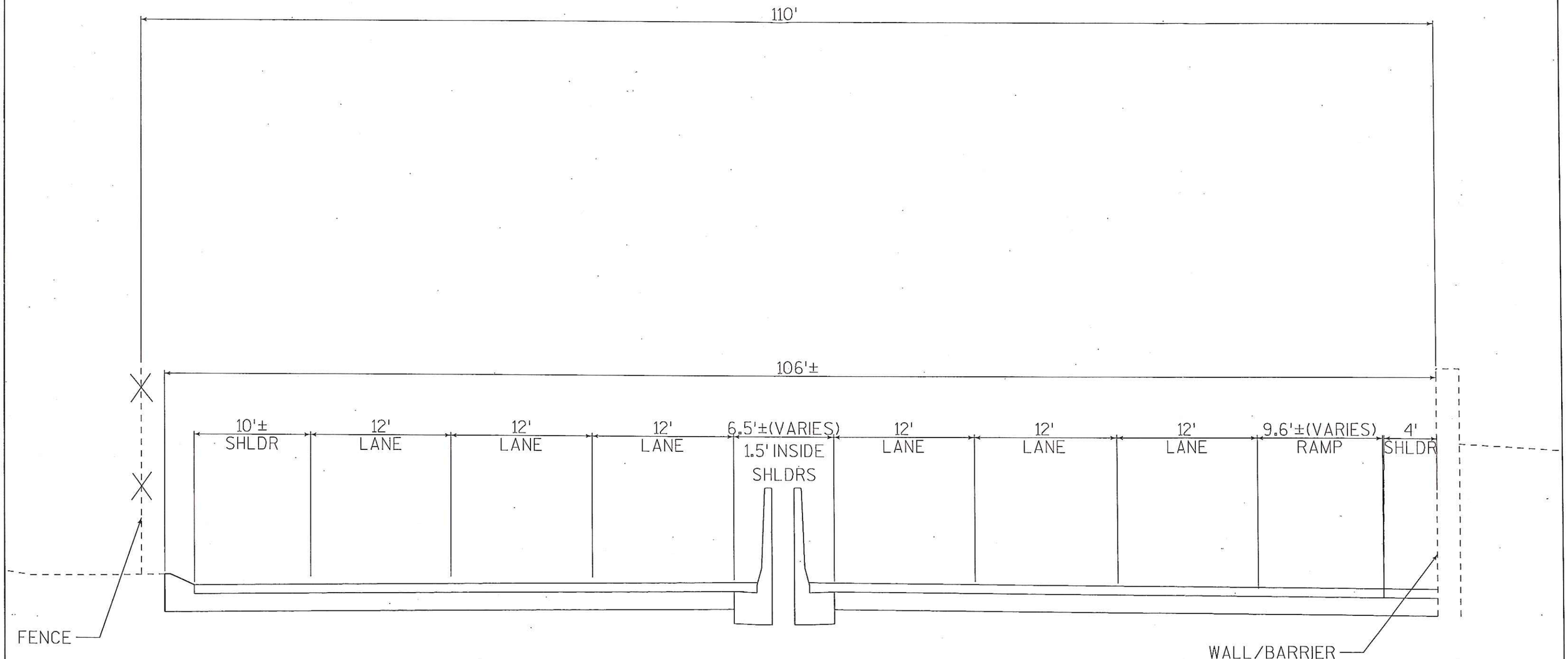
As part of the at-grade alternative, the Hawley Road and Mitchell Boulevard interchanges would be removed from I-94. By eliminating the interchanges, there would be no weaving traffic in this segment of the project. This would correct the existing deficient *ramp spacing* between Hawley Road and the 68th/70th Street interchange to the west and the Mitchell Boulevard interchange to the east. Additionally, eliminating the Mitchell Boulevard interchange would remove the *left-hand exit and entrance* to/from Mitchell Boulevard on eastbound I-94 and the *left-hand entrance* from Mitchell Boulevard to westbound I-94.

The best option to maximize safety and traffic operations in the width available for the 8-lane at grade typical section is the eight 11-foot lanes and 2-foot inside and outside shoulders, and remains the one 8LAG alternative still under consideration as a potential preferred alternative. The 8LAG has been evaluated with all possible scenarios, and all additional TDM and TSM measures would have to be implemented to improve operations. The combination of the 8LAG with TDM and TSM measures in the regional plan would not include any of the additional elements beyond the regional plan. Several of the measures would have to be implemented regionally to be effective. Closing on-ramps during peak hours could affect the development potential of the business corridors that it serves to the north and south of the freeway. It would also place greater pressure on the already strained adjacent interchanges and local roads. The increased traffic could diminish the business environments along these arterials by creating more conflicts between pedestrians and vehicles and increasing the potential for more vehicle collisions. Local stakeholders have expressed concerns that these corridors are already impacted by high traffic volumes and additional traffic congestion on local roads could discourage future business investment. Finally, further investigation is needed for the Half Hawley interchange.

Even though none of the additional elements are included with the 8LAG, all of the safety elements considered are incorporated. Some of these mitigation strategies for both lane and shoulder widths are aimed to enhance the driver's ability to stay within the lane. The roadside delineators can also help drivers see changes in roadway geometry. The DMS can provide advance warnings to drivers if a lane was closed or an incident had occurred. Furthermore, the ramp gates can be used to temporarily close a ramp for construction, to perform maintenance activities, to manage special events, when severe weather conditions are present or when travel on a roadway is unsafe, and if an incident has occurred on the freeway.

WisDOT and FHWA are retaining both the 8LAG and DD design alternatives throughout the balance of the NEPA phase. The contrasting engineering, performance, impact, and cost differences inherent in each alternative are in some cases significant, warranting additional study and stakeholder feedback opportunities as the Draft EIS, Final EIS, and ROD processes are undertaken over the next 12-16 months. No determination of a preferred alternative will be made until after the conclusion of the full DEIS availability period, and following consideration of stakeholder feedback, testimony, and additional engineering analyses.

[4] https://www.dot.gov/fastlane/moving-forward-safe-effective-and-strong-transportation



EXISTING I-94 TYPICAL SECTION

EXHIBIT 1

8 Lanes at grade
Dimensions of Substandard features

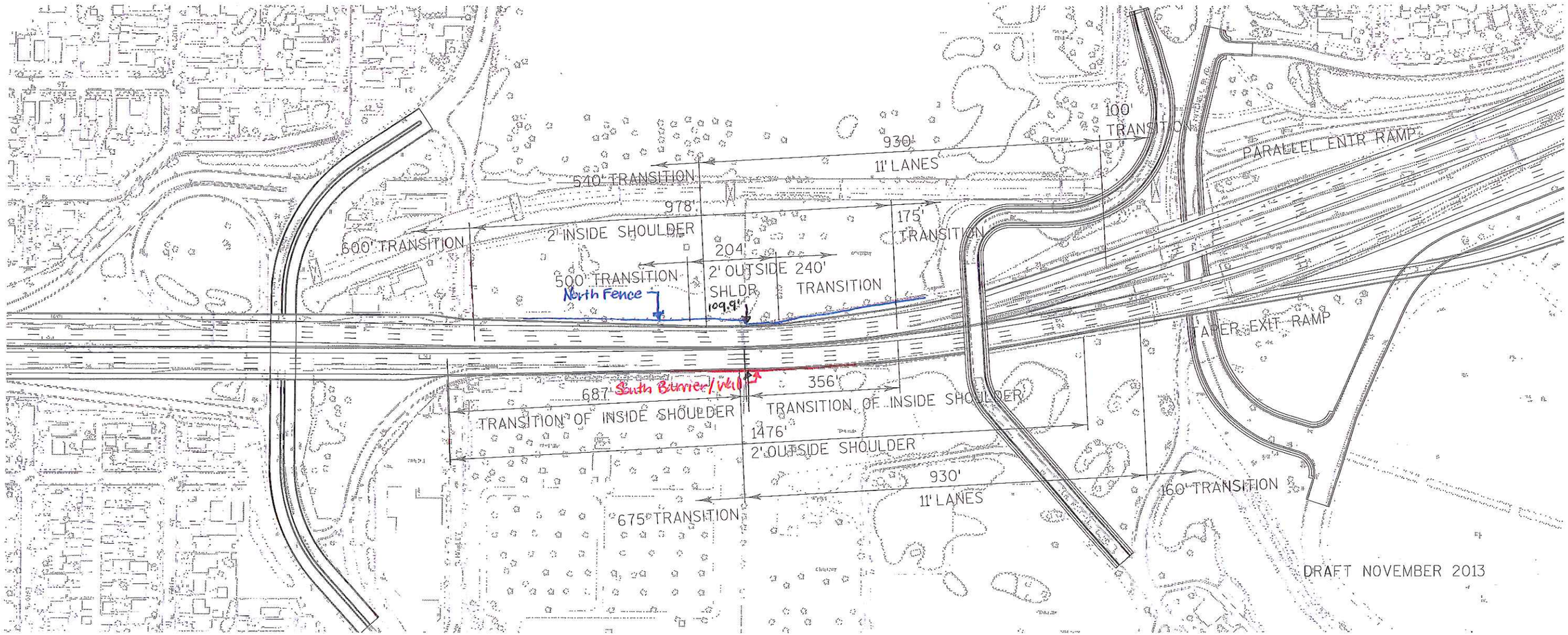


EXHIBIT 2